EFFECT OF DIFFERENT MATURITY STAGES ON THE PHYSICAL QUALITY AND PHYSICOCHEMICAL CHARACTERIZATION OF MR343, MR345 AND MR346 IN IADA KETARA, JERTEH, TERENGGANU

Amir Syariffuddeen Mhd Adnan
Rice Research Centre, Malaysian Agricultural Research & Development Institute (MARDI),
MARDI Headquarters, Persiaran MARDI-UPM,
Serdang, Selangor, Malaysia.
Email: asyariff@mardi.gov.my

Jeeven a/l Karruppan
Rice Research Centre, Malaysian Agricultural Research & Development Institute (MARDI),
MARDI Headquarters, Persiaran MARDI-UPM,
Serdang, Selangor, Malaysia.
Email: jeeven@mardi.gov.my

Siti Aisyah Sanusi
Rice Research Centre, Malaysian Agricultural Research & Development Institute (MARDI),
MARDI Headquarters, Persiaran MARDI-UPM,
Serdang, Selangor, Malaysia.
Email: aisyah@mardi.gov.my

Norfazillah Razali
Rice Research Centre, Malaysian Agricultural Research & Development Institute (MARDI),
MARDI Headquarters, Persiaran MARDI-UPM,
Serdang, Selangor, Malaysia.
Email: norfazillah@mardi.gov.my

Muhammad Izzuddin Sabar Abdullah
Rice Research Centre, Malaysian Agricultural Research & Development Institute (MARDI),
MARDI Headquarters, Persiaran MARDI-UPM,
Serdang, Selangor, Malaysia.
Email: izzu@mardi.gov.my

ABSTRACT

Information on Malaysian rice varieties rice quality based on different maturity stages are still limited. In order to optimize high yield and bertter quality of rice selection of right maturity stage is essential. Thus the aim of this study was to determine the ideal maturity stage to achieve good physical quality and physicochemical characterization in newly developed MARDI rice lines named MR343, MR345 and MR346. These varieties are grown in the IADA KETARA, Jerteh, Terengganu. The experiment was implemented with five replications for each varieties and they are harvested at stages of 80%, 85% and 90% maturity. The physical qualities evaluated are grain size (length, width, length-to-width ratio), milled rice recovery (MRR) and head rice yield (HRY) Analysis of physicochemical properties involves determination of gel consistency (GC), alkaline spreading value (ASV), cooking time (CT), rice elongation ratio (RER) and volume of expansion (VOE). These had demonstrated that factors of variety, maturity stages and interaction between variety and maturity stages mainly contribute to the significant effect on the physical quality and physicochemical properties of rice. The findings of this study can be used as a reference for determining the ideal maturity stage for harvesting these MARDI new rice varieties for better yield and good characteristic of rice.

Keywords: Physical quality, Physicochemcial Properties, MARDI, MR 343, MR 345 and MR 346

INTRODUCTION

Rice (Oryza sativa L.) is a staple food for many Asian countries (FAO,2018). Rice has ranked at the third place after maize and wheat. FAO had reported in year 2016 estimated paddy cultivation area worldwide almost 161.3 million hectares and contributed to rice production of 747.9 million tons. Rice considered as a pivotal source for human nutrition, providing energy and important for food security and Zhu et. al, (2010) has reported beside contributing an adequate energy for mankind in the form of calories, rice also a major source for vitamins such as thiamine, rinoflavin and niacin. Meanwhile, El-Kady et al., (2013) has reported rice act as one of the most common foods within other cereals for its nutritional quality since it has higher digestibility, biological value, and protein efficiency ratio owing to the presence of a higher percentage of lysine compared to wheat.

Consumer prefer selection of fine rice varieties due to its good nutritional quality, palatability, taste, cooking quality and fragrance (Kaul et al., (1982). Grain quality is defined as combination of several physicochemical characteristics of grain included higher milling rice recovery, grain rice, shape and its behaviour upon cooking, the taste and flavour of cooked rice. (Dela Cruz and Khush, 2000). Environment condition and crop managemnet practices are among vital factor influence the productivity and quality of rice. Morever, maturity duration for harvesting the rice also ensures good quality for production of good quality rice with higher yeld (Ali et al., 1990). Grain yield and its quality critically depend on the right judgement of maturity period for harvesting. Early maturity period for rice harvesting can led to increase the empty or unfilled together with immature grains. Thus, it will affected to the premature grains that contribute to the partially chalky kernel and milk-white kernels and increase the thickness of the bran and aleuronic layers (Hossain et al., 2009). Therefore, this study was conducted to determine the ideal maturity stage that can consistently conserve the ideal physical quality and physicochemcial properties on MARDI new rice planted in the Local Verification Trial (LVT) plots.

MATERIAL AND METHODS

Sample Preparation

Rice samples namely MR343, MR345 and MR346 were harvested from research cultivation plot in IADA Ketara, Terengganu at different maturity period (80%, 85% and 90%). The maturity period is measured by calculating the percentage of mature grains and immature (greenish) grain from selected stalk from each paddy varieties and its as equation formula as below:

$$Maturity\ Period\ (\%) = \frac{Mature\ Grain}{Mature\ Grain + Immature\ Grain} x\ 100$$

The harvested rice is dried (oven and also under sunlight) to achieve the ideal moisture content of 13-14%.

Determination of Physical Quality

The rice dimension (length, width, length and width ratio), milling rice recovery (MRR) and head rice yield (HRY) are evaluated. Paddy dimension has measured using a vernier caliper. Rice (200 g) was dehusked using a dehusking machine (THU35B, Satake, Japan). The resulting brown rice is polished to remove the bran layer using a polishing machine (TM05C, Satake, Japan). Head rice and broken rice were separated using a cylindrical grading machine (TRG05B, Satake, Japan) using cylinders of 4.75 and 3.75 mm size. Rice yield is calculated based on the formula below:

i. Milling Rice Recovery, MRR (%) = Weight of rice / weight of paddy x 100
ii. Head Rice Yield, HRY (%) = Weight of head rice / weight of rice x 100

Figure 1: Laboratory scale instruments (dehusking, polishing and cylinder grading machines) used to obtain MRR and HRR

Determination of physicochemical properties

a) Amylose Content of Rice
The analysis were done using Juliano et. al (1982) method. Rice powder of 0.1g was treated with 1.0ml of 95% ethanol and 9.0ml of 1N sodium hydiroxide in 100ml volumetric flask. The sample were heated in boiling water bath for 20 min to gelatinized the starch. 5.0ml of each test/standard/blank solution was then transferred to a 100ml volumetric flask followed by adding 1.0ml of 1N acetic acid and 2.0ml of iodine solution. The volume adjusted to 100ml with distilled water and the the reaction mixture were left stand for 20 min at room temperature. Absorbance was then recorded in a UV-Vis Spectrophotometer at 620nm (Agilent, USA).

b) Gel Consistency
Gel consistency was done followed as Cagambang et. al (1973) techniques where an amount of 0.1g rice powder was added with 0.2ml of 95% ethanol containing 0.025% thymol blue. The mixture were thoroughly vortex before add another 2.0ml of 0.2N potassium hydroxide (KOH) and vortex again. The vortexed mixture place in boiling water then keep at ambient temperature and cool it in ice for 15-20 min. The length of the gel was measured by laying the tube with the reaction mixture over a graph paper after 30-60 minutes.

c) Alkaline Spreading Value (ASV)

10 kernel of milled rice was added with 15ml of 1.7% KOH. The kernel was stand for 23 hours at 30ºC or ambient temperature. The degree of spreading was measured and total score grain for ASV was calculated as equation below:

$$\text{ASV Score} = \text{Total Grain Score} / 10 \text{ grain}$$

d) Cooking Test (Grain Elongation, Volume of Expansion)

100mg of head rice has placed in a test tube and was placed in 400mL beaker filled with 160mL distilled water. When the distilled water has boiled, lift the test tube, toss for 2 minutes and measure the length of rice. Volume of expansion was measured as equation below:

$$\text{Volume of Expansion} = \text{Height of cooked rice} / \text{Height of rice}$$

e) Cooking Time

5 gram of head rice was placed in 250ml distilled water and heated. After 10 min, 10 grains of rice was check for every min to ensure it cooked. The time for the rice cooked was measured and the test has done replicately.

The entire recorded data then has analyzed using software Statistical Analysis System (SAS) version 9.4. ANOVA analysis of variance has implemented and the means were compared based on the Least Significant Difference (LSD) test at $p = 0.05$ probability level.

Table 1: Analysis of variance (mean square) for each physical quality and physicochemcial properties of rice

	DF	Grain Length	Grain Width	Ratio L/W	Milling Rice Recovery	Head Rice Yield	Amylose Content	Gel Consistency	Alkaline Spread Value	Cooking Time	Elongation	Volume of Expansion
Rep	4	0.224ns	7.362ns	0.205ns	0.540ns	25.035ns	1.061ns	18.14ns	0.040ns	0.051ns	0.005ns	0.034ns
Var	2	0.710ns	8.788ns	0.785*	0.682ns	1399.05*	503.248**	1718.955**	3.516**	56.556**	0.258**	0.173*
Mtg	2	0.203ns	7.907ns	0.458ns	9.086**	9.27ns	2.898ns	173.755ns	0.010ns	3.092**	0.060*	0.023ns
Var*Mtg	4	0.549ns	7.196ns	0.498ns	8.431*	170.55*	2.473ns	350.456*	0.302*	5.817**	0.003ns	0.071*
Error	32	0.245	7.233	0.253	2.140	32.67	1.466	54.169	0.049	0.023	0.005	0.023
CV		7.034	110.198	14.794	2.138	8.69	5.648	15.100	7.820	0.634	5.216	3.610
Mean		7.046	2.440	3.405	68.520	65.77	21.440	48.500	2.840	24.136	1.414	4.176

*, ** significant at p = 0.05 or 0.01, respectively. ns: not significant, Where: DF = Degree of freedom, CV = Coefficient of variation, Rep = Replication, Var= Variety, Mtg= Maturity, Var*Mtg = Interaction Variety towards Maturity

Table 2: Effect Of different maturity periods on the physical charaterizations of MR343, MR345 and MR346 in IADA KETARA

Line	Maturity	Milling Rice Recovery	Head Rice Yield	Grain Length	Grain Width	Ratio L/W	Amylose Content	Gel Consistency	Alkali Spreading Value	Grain Elongation	Volume of Expansion	Cooking Time
343	80	68.11±0.83^{b}	50.64±3.25^{b}	7.55±0.58^{a}	2.06±0.04^{a}	3.67±0.26^{a}	26.06±0.65^{a}	35.60±2.23^{a}	2.40±0.44^{a}	1.39±0.05^{ab}	4.45±0.04^{a}	25.59±0.14^{a}
	85	67.11±0.70^{a}	59.23±2.51^{ab}	6.72±0.14^{a}	2.16±0.03^{a}	2.59±0.28^{a}	26.06±0.85^{a}	40.00±2.28^{a}	2.34±0.13^{a}	1.45±0.00^{a}	4.17±0.06^{b}	25.39±0.04^{a}
	90	70.87±0.45^{a}	63.39±4.18^{a}	6.86±0.13^{a}	2.16±0.03^{a}	3.19±0.05^{a}	26.28±0.36^{a}	37.20±4.75^{a}	2.38±0.09^{a}	1.32±0.04^{a}	4.14±0.05^{b}	25.59±0.14^{a}
345	80	68.49±0.63^{a}	76.48±1.34^{a}	6.63±0.09^{b}	1.89±0.03^{b}	3.51±0.09^{a}	15.96±0.77^{a}	64.20±2.87^{a}	2.64±0.13^{b}	1.53±0.01^{a}	4.21±0.04^{a}	22.30±0.05^{b}
	85	67.65±0.89^{a}	74.89±2.39^{a}	7.09±0.11^{a}	2.05±0.05^{a}	3.46±0.09^{a}	14.88±0.35^{ab}	55.20±3.72^{a}	2.70±0.07^{b}	1.61±0.05^{a}	4.24±0.03^{a}	20.18±0.03^{c}
	90	69.62±0.27^{a}	78.11±1.00^{a}	6.78±0.08^{b}	1.97±0.05^{ab}	3.44±0.07^{a}	14.06±0.09^{b}	57.60±0.98^{a}	3.00±0.08^{a}	1.52±0.01^{a}	4.20±0.07^{a}	23.27±0.03^{a}
346	80	68.16±0.53^{a}	68.42±2.56^{a}	7.31±0.05^{a}	2.05±0.02^{a}	3.56±0.05^{a}	23.14±0.59^{a}	38.80±3.00^{b}	3.40±0.08^{ab}	1.31±0.02^{ab}	4.00±0.16^{a}	25.42±0.03^{a}
	85	68.99±0.77^{a}	62.26±2.22^{ab}	7.34±0.09^{a}	2.02±0.05^{a}	3.63±0.06^{a}	24.06±0.16^{a}	45.40±3.51^{b}	3.56±0.06^{a}	1.37±0.01^{a}	4.04±0.01^{a}	25.27±0.03^{b}
	90	67.71±0.69^{a}	58.48±1.68^{b}	7.15±0.16^{a}	2.02±0.04^{a}	3.58±0.12^{a}	22.46±0.41^{a}	62.40±3.61^{a}	3.06±0.14^{a}	1.21±0.04^{b}	4.12±0.03^{b}	24.21±0.04^{c}

Means within a factor and column followed by the same alphabet are not significantly different at p = 0.05 by using LSD test

RESULTS AND DISCUSSION

Results of analysis of variance (ANOVA) as in Table 1 showed physical quality of rice (length and width of rice and it's ratio of length and width is not significantly affected by any factor involved in the study. MRR and HRY were significantly different by maturity stage and the interaction of maturity stage with variety (Table 1). For physicochemical properties, it can be seen that variety types and maturation stages have significant effect on amylose content (AC), gel consistency (GC), alkaline spread value (ASV), cooking time, rice elongation and also rice expansion volume (VOE). For physical quality of grain, in terms of rice grain size, all varieties at entire maturity stage show the same trend that the length of the rice grain is exceeded 6.20 mm which is categorized as long rice grain. MR 346 has recorded the longest rice grain size which is between 7.15-7.34mm. While MR 343 and MR 345 are respectively between 6.68-7.55mm and 6.63-7.09mm in length. For width of rice grains, averagely MR 343, MR 345 and MR 346 possessed width greater than 2.00 mm. The ratio of length and width of rice grains for all varieties is more than 3.00 mm (except MR 343 at 85% maturity) which can be categorized as long and slender. MR 346 has exhibited a length to width ratio between 3.53-3.63 mm, higher than MR 343 and MR 345.

For milling rice recovery (MRR), all varieties achieved MRR above 67% which is in the ideal range (68-72%) as reported by IRRI. It can be seen that MR 343 at 90% maturity recorded the highest MRR with percentage of 70.90% compared to 68.11% at 80% and 67.11% at 85% maturity. Meanwhile, the MRR for the MR345 and MR346 recorded MRR range of 67-70%. HRY data shows that MR 345 has produced the highest HRY percentage (74.9-78.1%), followed by MR 346 (67.8-69.9%). MR 343 shows the lowest HRY percentage which is between 50.6-63.6% at the maturity stage of 80% and harvesting period at this early maturity stage potentially can cause rice grains that are chalky and immature and at the same time potentially affecting the rice kernel structural integrity during the milling process (Hossain et.al, 2009). In term of physicochemical properties, different variety has contributed the significant effect on amylose content. It can be seen that MR 343 was the high amylose rice since it possessed the highest AC above 25% for each maturity stages. This followed by MR 346 that classified as intermediate amylose rice with range 20-25% and MR 345 has classified as low amylose rice with value AC below 20%. MR 343 with highest AC in the range 26.06±0.05% to 26.28±0.36% also has shown high volume of expansion (VOE) with value of 4.14±0.05 to 4.45±0.04 compare to others two varieties. This result was agreed with the report by Ashish Jan et. al (2012) that mentioned on correlation the high value AC, it will show high VOE with high degree of flakiness instead represented low glysemic index. However, for MR 345 and MR 346 there is no significant different on both VOE value.

Gel Consistency is the chemical properties that measuring the tendency of cooked rice to harden during cooling. It was recorded that MR 343 with entire maturity stages exhibited medium GC with value between 35.60±2.23 to 40.00±2.28 mm length of gel. At maturity 90%, MR 345 also exhibited a medium GC also similar as MR 346 at 80% and 85%. However, For MR 345, at maturity 80% and 85% it showed the GC on soft category similar trend as MR 346 rice at 90% maturity. This result concluded that the distribution of GC was not significant different in MR 343 but has a significant effect in different maturity stages for MR 345 and MR 346. The soft category of GC define that the cooked rice has a higher degree of tenderness and this category is the preferred characteristic for rice. Alkali Spreading Value (ASV) is the chemical characteristic that measured for gelatization temperature (GT) which reflect to the temperature at which about 90% of starch granules swelled irreversibly in hot water and this associated with the cooking time of rice kernel (Heda and Reddy, 1986). Data on Table 2 showed, there was a significant different on ASV from source of different variety towards the maturity stages. MR 343 exhibited ASV range from 2.34±0.13to 2.40±0.44 meanwhile MR 345 and MR 346 in the range of 2.64±0.13 to 3.00±0.08 and 3.06±0.14 to 3.56±0.06 respectively. Overall, all of the varieties involved in this study were in the category of "high" ASV which denoted for high gelatinization temperature (above 74ºC) which indicated require more water for rice to cook and less elongation. Entire variety has showed less elongation value at 1.21±0.04 to 1.61±0.05 with cooking time between 20.18±0.03 sec to 25.59±0.14 sec. MR 345 with the highest elongation at 1.52±0.01 to 1.61±0.05 also exhibited the least time duration to cook at 20.18±0.03 sec to 23.37±0.03 compare to both MR 343 and MR 346.

CONCLUSION

Three source factor of variety, maturity stages and interaction between variety and maturity stages mainly contribute to the significant effect of the physical quality and physicochemical properties of MR343, MR345 and MR346. However, the ideal maturity stage for harvesting is depend on the type of varieties in respect of physical quality and physicochemical characterization obtained. Comparison on variety has shown that MR345 exhibit good characteristic at each maturity stages with highest MRR and HRY compare to others but produce in low amylose content. MR346 exhibited also good physical quality on MRR and HRY with intermediate amylose which is can catogerized as most preferable rice for consumer. The data from this study can be used as a guidance for selection the best variety with further analysis regarding the physical and physicochemical characterization based on different location should be add on and conducted in further works

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